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Kurokawa et al.

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[54] **HANDS-FREE CIRCUITRY PROVIDING AUDIO SIGNAL ADJUSTMENT BASED ON SPEAKER VOLUME VALUE**

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Related U.S. Application Data

[63] Continuation of Ser. No. 896,616, Jun. 10, 1992, abandoned.

[30] **Foreign Application Priority Data**

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[51] **Int. Cl.**[6] **H04B 1/38**; H04M 9/08

[52] **U.S. Cl.** **455/79**; 455/89; 379/388; 379/390

[58] **Field of Search** 455/79, 89, 116, 455/234, 151, 355; 379/388, 389, 390

[56] **References Cited**

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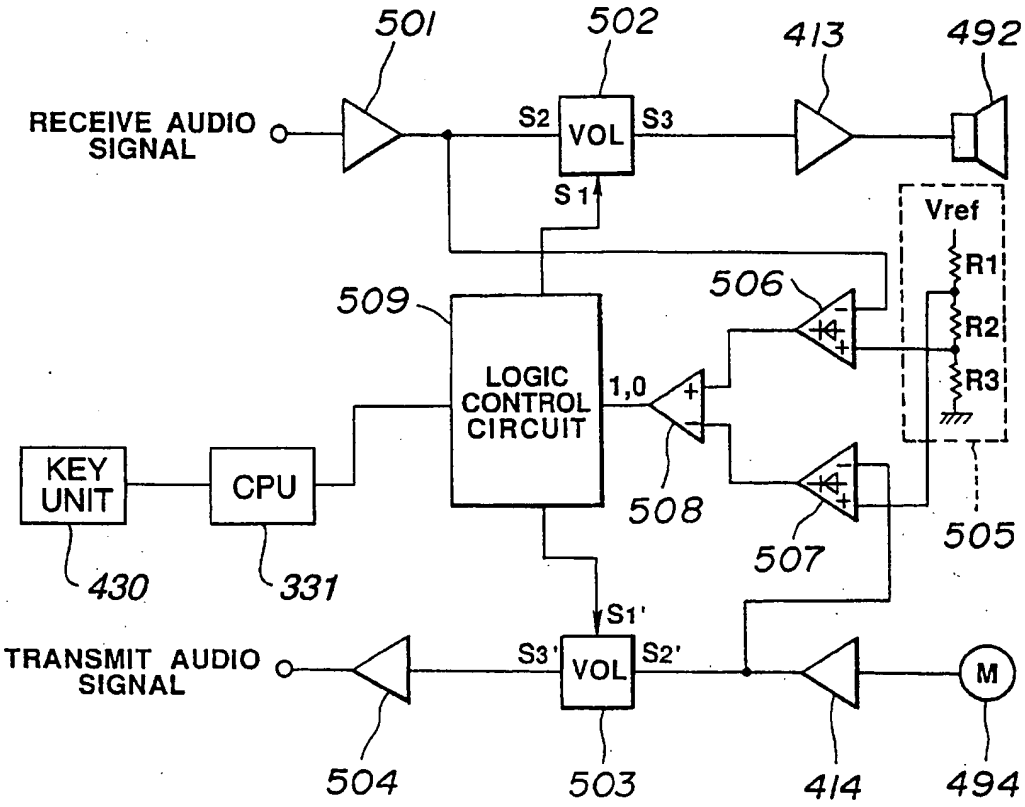
[57] **ABSTRACT**

A hands-free circuitry in which, in order to prevent howling caused by acoustic coupling between a speaker and a microphone, a loss is inserted in a transmit audio path in a receive mode while a loss is inserted in a receive voice path in a transmit mode and values of the losses are controlled according to the volume set value of the speaker. Since the quantities of the losses are minimized when a howling margin is sufficient, simplex communication can be prevented that a user cannot listen to party's receive voice signal due to excessive attenuation.

12 Claims, 10 Drawing Sheets



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TITLE: Hands-free circuitry providing audio signal adjustment based on speaker volume value

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Abstract Text - ABTX (1):

A hands-free circuitry in which, in order to prevent howling caused by acoustic coupling between a speaker and a microphone, a loss is inserted in a transmit audio path in a receive mode while a loss is inserted in a receive voice path in a transmit mode and values of the losses are controlled according to the volume set value of the speaker. Since the quantities of the losses are minimized when a howling margin is sufficient, simplex communication can be prevented that a user cannot listen to party's receive voice signal due to excessive **attenuation**.

Application Filing Date - AD (1):

19950217

Brief Summary Text - BSTX (8):

In FIG. 10, a transmit audio signal outputted from a microphone 5 is transmitted to a transceiver (transmitter) (not shown) through an **attenuating** circuit 71 and an interface circuit 8 and then transmitted to a telephone network. The **attenuating** circuit 71, which comprises a resistor and a switch SW connected in parallel to the resistor, performs its **attenuating** function by turning on and off the switch SW.

Brief Summary Text - BSTX (9):

On the other hand, a receive audio signal, which is transmitted from the other party and received at the transceiver (receiver) (not shown), is inputted into a speaker 4 through an interface circuit 1, an **attenuating** circuit 2 and an amplifier 3. The **attenuating** circuit 2 functions to adjust the sound volume of the speaker 4.

Brief Summary Text - BSTX (11):

A logic control circuit 13 judges, on the basis of an output of the comparing circuit 12, whether or not the hands-free control circuit is in the transmit mode or in the receive mode, and controls the **attenuating** circuit 7 or 2 according to its judgement result under the control of a command received from a CPU (not shown).

Brief Summary Text - BSTX (12):

When the logic control circuit 13 judges that the hands-free control circuit is in the transmit mode, the receive audio signal is **attenuated**; while, when the logic control circuit 13 judges that the circuit in the receive mode, the transmit audio signal is **attenuated**, as described above.

Brief Summary Text - BSTX (13):
FIG. 11 shows **attenuation** characteristics of transmit and receive levels in the transmit and receive modes when the above control is carried out.

Brief Summary Text - BSTX (14):
As shown in FIG. 11, in the prior art hands-free control circuit, the receive audio signal and the transmit audio signal are selectively **attenuated** depending on the transmit or receive mode with a constant **attenuation** factor.

Brief Summary Text - BSTX (15):
Because the **attenuation** factor is constant, when the mode is changed from the receive mode to the transmit mode under such a condition that the receive audio volume is lowered by user's manual operation to a speaker volume, the receive audio volume will be further **attenuated** according to the constant **attenuation** factor.

Brief Summary Text - BSTX (16):
When the receive audio volume is low, a howling margin is sufficiently high with a small howling possibility. However, further **attenuating** the receive audio volume based on the constant **attenuation** factor is undesirable because the receive audio volume is **attenuated** down to an unnecessary low level.

Brief Summary Text - BSTX (18):
As described above, in the conventional hands-free control circuit, the factor of **attenuation when attenuating** the receive audio signal or the transmit audio signal according to the transmit or receive mode is always constant. Thus, the conventional hands-free control circuit has a problem that, when switching is carried out from the receive mode to the transmit mode with the speaker volume set to a low level, the receive audio volume is **attenuated** too far. Therefore, the other party's voice becomes hardly audible, that is, the simplex communication is incurred.

Brief Summary Text - BSTX (20):
It is therefore an object of the present invention to provide a hands-free circuitry for a telephone system, etc. which can **attenuate** a transmit audio signal or a receive audio signal with an **attenuation** factor being always optimum.

Brief Summary Text - BSTX (21):
It is another object of the present invention to provide a hands-free circuitry which can suppress the excessive **attenuation** of the receive audio volume when switching is carried out from the receive mode to the transmit mode under the situation where the speaker volume is set to a low level, thereby preventing the simplex communication.

Brief Summary Text - BSTX (23):
With this construction of the hands-free circuitry, the receive audio signal is **attenuated** by the receive audio **attenuator** in the transmit mode in which the level of the transmit audio signal is higher than that of the receive audio

signal, the transmit audio signal is **attenuated** by the transmit audio **attenuator** in the receive mode in which the level of the receive audio signal is higher than that of the transmit audio signal, and the audio signal **attenuation** of the receive or transmit audio **attenuator** is controlled depending on a speaker volume control.

Drawing Description Text - DRTX (5):
FIG. 5 is a chart for illustrating various signals associated with **attenuation** control in the electronic volume controller of FIG. 4;

Drawing Description Text - DRTX (7):
FIG. 7 is a graph showing an example of **attenuation** characteristics of audio signals in transmit and receive modes in the hands-free control circuit according to the present invention;

Drawing Description Text - DRTX (8):
FIG. 8 is another example of the **attenuation** characteristics of the audio signals in the transmit and receive modes of the hands-free control circuit according to the present invention;

Drawing Description Text - DRTX (9):
FIG. 9 is still another example of the **attenuation** characteristics of the audio signals in the transmit and receive modes of the hands-free control circuit according to the present invention;

Drawing Description Text - DRTX (11):
FIG. 11 is the **attenuation** characteristics of the audio signals in the transmit and receive modes of the conventional hands-free control circuit.

Detailed Description Text - DETX (4):
Antenna 200 is provided outside of car 14 while radio device 300 is mounted within a trunk of car 14. Telephone set 400 includes a **telephone body** 400a and a handset 400b which are placed near the driver's seat in car 14.

Detailed Description Text - DETX (22):
Telephone body 400a of telephone set 400 shown in FIG. 2 mainly includes amplifiers 413, 414; a hands-free controller 415; **attenuators** 415a, 415c; switches 416, 417; a hands-free microphone 494; a speaker 492; a hook switch (not shown); and an on/off switch (not shown). Amplifier 413 amplifies an audio signal from audio unit 337 of radio device 300 and outputs the resulting signal through speaker 492.

Detailed Description Text - DETX (24):
Hands-free controller 415 controls the **attenuation** factor of **attenuator** 415a which **attenuates** an audio signal input to amplifier 413 and also the **attenuation** factor of **attenuator** 415c which **attenuates** an audio signal output from amplifier 414.

Detailed Description Text - DETX (45):

The logic control circuit 509 judges the transmit or receive mode on the basis of an output of the comparing circuit 508 and controls the electronic volume controllers 502 and 503 according to its judgement result to provide suitable **attenuation** factors to the receive and transmit audio signals.

Detailed Description Text - DETX (46):
For the control of the **attenuation** factors, in the hands-free control circuit of the present invention, the electronic volume controllers 502 and 503 are used as an example of the **attenuating** circuits.

Detailed Description Text - DETX (47):
The electronic volume controllers **attenuate** the receive and transmit audio signals according to chopper signals externally supplied. The factor of the **attenuation** to the receive and transmit audio signals may be determined according to the form of the chopper signals.

Detailed Description Text - DETX (51):
The chopper signal S1 becomes "on" or "off" level with a predetermined duty ratio. The transmission gate 5021 outputs the receive audio signal S2 only when the chopper signal S1 is "on" level. Thus, the transmission gate 5021 outputs a signal S21 shown in FIG. 5(c). The signal S21 is then passed through the lowpass filter 5022 where the level is lowered as shown in FIG. 5(d). Thus, the electronic volume controller 502 outputs an **attenuated** receive audio signal S3.

Detailed Description Text - DETX (52):
Similarly, the electronic volume controller 503 **attenuates** a transmit audio signal S2' supplied from the amplifier 414 with the use of a chopper signal S1' supplied from the logic control circuit 509, and outputs an **attenuated** transmit audio signal S3'.

Detailed Description Text - DETX (53):
As described above, the **attenuation** factor of the electronic volume controllers 502 and 503 is determined the duty ration of the chopper signal supplied from the logic control circuit 509. Thus, the factor of **attenuation** to the transmit and receive audio signals can be controlled.

Detailed Description Text - DETX (55):
When the logic control circuit 509 judges that it is in the transmit mode based on the output "0" of the comparing circuit 508, the logic control circuit 509 controls the duty ration of the chopper signal S1 to be provided to the electronic volume controller 502 so that the receive audio signal S2 is **attenuated** to the signal S3.

Detailed Description Text - DETX (56):
When the logic control circuit 509 judges that it is in the receive mode based on the output "1" of the comparing circuit 508, it controls the duty ratio of the chopper signal S1' to be provided to the electronic volume controller 503 so that a transmit audio signal S2' is **attenuated** to a signal S3'.

Detailed Description Text - DETX (57):

When **attenuating** the receive audio signal or transmit audio signal by selectively controlling the **attenuation** factor of the electronic volume controller 502 and 503 as described above, the hands-free control circuit 415 controls the **attenuation** factor while considering the current setting of the volume for the speaker 492 (hereinafter refer to speaker volume value).

Detailed Description Text - DETX (61):

FIG. 7 is a graph showing **attenuation** factor of transmit and receive **level with respect to the speaker** volume value in which a line a-1 represents the **attenuation** factor of transmit **level with respect to the speaker** volume value in the transmit mode, lines a-2 and a-3 represent the **attenuation** factor of transmit **level with respect to the speaker** volume value in the receive mode, a line b-1 represents the **attenuation** factor of receive **level with respect to the speaker** volume value in the receive mode and lines b-2 and b-3 represent the **attenuation** factor of receive **level with respect to the speaker** volume value in the transmit mode.

Detailed Description Text - DETX (62):

In the line a-1 in which the hands-free control circuit is in the transmit mode, the transmit **level is constant irrespective of the speaker** volume value. When the transmit mode is switched to the receive mode, the transmit level is **attenuated**. According to this embodiment, it is so designed that the **attenuation** factor of the transmit **level is decreased in a smaller speaker** volume value compared with that in a larger speaker volume value as shown in the line a-2. This is in contrast to conventional hands-free control circuits in which the **attenuation** factor in the transmit **level is constant irrespective of the speaker** volume value.

Detailed Description Text - DETX (63):

For a telephone system in which its communication path has a small communication transmission loss, the **attenuation** factor may be controlled such that it becomes larger than that in the line a-2. This increased **attenuation** factor is shown in the line a-3.

Detailed Description Text - DETX (64):

In the line b-1 in which the hands-free control circuit is in the receive mode, the receive **level changes in proportion to the speaker** volume value. When the receive mode is switched to the transmit mode, the difference of the **attenuation** factor between the transmit mode and the receive mode decreases as the speaker volume value decreases.

Detailed Description Text - DETX (65):

For a telephone system in which its communication path has a small communication transmission loss, the **attenuation** factor may be controlled such that it becomes larger than that in the line b-2. This increased **attenuation** factor is shown in the line b-3.

Detailed Description Text - DETX (66):

The **attenuation** factors for **attenuating** the transmit or receive **level according to the speaker** volume value in such a manner as shown in FIG. 7 is

set in the control unit 5091 of the logic control circuit 509 shown in FIG. 6. Based on a binary data supplied from the comparing circuit 508 and a volume setting value supplied from the CPU 331, the control unit 5091 outputs data indicative of the **attenuation** factor in transmit or receive level to the duty ratio converters 5092 and 5093. The duty ratio converters 5092 and 5093, in turn, supply chopper signals S1 and Si' to the electronic volume controllers 502 and 503, respectively to **attenuate** the transmit or receive level.

Detailed Description Text - DETX (67):

With the above-described construction of the hands-free control circuit, even when switching is carried out from the receive mode to the transmit mode under a condition that the speaker volume is lowered by the operation of the key section 430, the receive volume will not **attenuated** to an excessive low level, thereby to prevent the simplex communication.

Detailed Description Text - DETX (68):

In the **attenuation** characteristics of FIG. 7, both of the transmit and receive audio signals are **attenuated** according to the volume set value of the speaker 492. In the hands-free control circuit of the present invention, however, such a control method may be employed in which either one of the transmit and receive audio signals is **attenuated** according to the volume set value of the speaker 492.

Detailed Description Text - DETX (69):

FIG. 8 shows an **attenuation** characteristics in which only the receive level is controlled in association with the volume set value of the speaker.

Detailed Description Text - DETX (70):

FIG. 9 shows another **attenuation** characteristics in which only the transmit level is controlled in association with the volume set value of the speaker.

Detailed Description Text - DETX (75):

The logic control circuit 509 controls the electronic volume controller 502 based on the output "0" of the comparing circuit 508, thereby to **attenuate** the receive audio signal. That is, the hands-free control circuit of the present invention provides a "waiting-state transmit mode".

Detailed Description Text - DETX (76):

In the waiting-state transmit mode, the receive audio signal is **attenuated** and the transmit audio signal is not **attenuated** during the no transmit/receive state. Accordingly, ambient noises such as running car noise in the side of the mobile telephone system are sent to the other party. Thus, the present invention can prevent such a situation that, as in the waning-state receive mode, the other party is put in the silent condition and worries that the line may be disconnected.

Claims Text - CLTX (2):

first adjusting means for varying a transmit **attenuation** factor, thereby adjusting the transmit audio signal;

Claims Text - CLTX (3):
second adjusting means for varying a receive **attenuation** factor, thereby adjusting the receive audio signal;

Claims Text - CLTX (6):
control means for activating one of the first adjusting means and the second adjusting means in response to the comparing means so as to control an adjustment of the activated one of the first adjusting means and the second adjusting means by continuously decreasing the **attenuation** factor of the activated adjusting means with a value of such **attenuation** factor before the activation of one of the first and second adjusting means being taken as a reference as the volume value of the speaker received from the input means decreases.

Claims Text - CLTX (7):
2. Hands-free circuitry according to claim 1, wherein the first and the second adjusting means are first and second **attenuating** means.

Claims Text - CLTX (8):
3. Hands-free circuitry according to claim 2, wherein the factor of at least either one of the first **attenuating** means and the second **attenuating** means is in proportion to the volume value of the speaker.

Claims Text - CLTX (9):
4. Hands-free circuitry according to claim 2, wherein the comparing means includes means for generating a level control signal in response to the volume value and the level control signal is applied to at least either one of the first **attenuating** means and the second **attenuating** means.

Claims Text - CLTX (10):
5. Hands-free circuitry according to claim 4, wherein the first and the second **attenuating** means are first and second electronic volume controllers, and the control means provides a chopper signal to at least either one of the first electronic volume controller and the second electronic volume controller, the chopper signal having a duty ratio which is determined by the mode signal and the volume value.

Claims Text - CLTX (18):
judging means for judging whether the circuitry is in a receive mode in which **attenuation** of the transmit audio signal is necessary or in a transmit mode in which **attenuation** of the receive audio signal is necessary based on comparison by the comparing means; and

Claims Text - CLTX (19):
another control means for controlling the second adjusting means such as to **attenuating** the receive audio signal at an **attenuation** factor of the speaker volume value when the circuitry is in the receive mode, and when the circuitry is in the transmit mode, the **attenuation** factor of the receive audio signal is increased compared with an occasion when the circuitry is in the receive mode and difference between the **attenuation** factors of the receive audio signal in the transmit mode and in the receive mode is continuously decreased as the

speaker volume value increases, and for controlling the first adjusting means such as to increasing the **attenuation** factor of the transmit audio signal as the speaker volume value increases only when the circuitry is in the receive mode.